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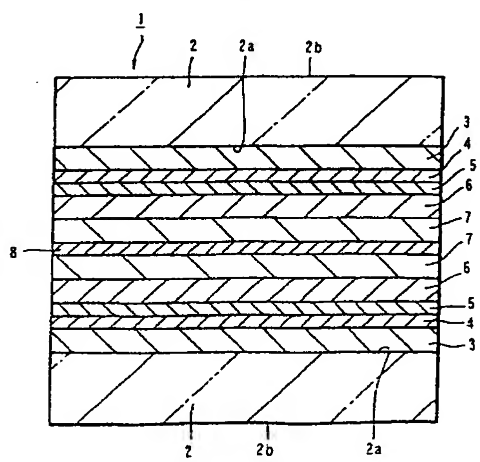
(54) **Optical recording medium**

(57) In order to ensure CAV recording/reproduction while preventing jitter increase and modulation decrease and thereby ensuring sufficient recording properties, even at a linear velocity in the range of 3.49 to 8.44 m/s, a first dielectric film, phase-versatile recording film, second dielectric film, reflection film and protective film are formed on a disc substrate having formed lands, grooves and wobbling on one major surface. The recording film is made of a GeInSbTe alloy, and the reflection film is made of an AgPdCu alloy or AlCu alloy. Composition of the GeInSbTe alloy is adjusted to contain Ge in the range of 1 to 6 wt%, In in the range of 2 to 6 wt%, and control Sb/Te in the range of 2.4 to 3.0. Composition of the AgPdCu alloy is adjusted to contain Cu not more than 1.5 wt%. Groove depth is controlled in the range of 30 to 40 nm, groove width in the range of 0.27 to 0.33 μm, thickness of the first dielectric film in the range of 65 to 80 nm, thickness of the recording film in the range of 12 to 18 nm, thickness of the second dielectric film in the range of 12 to 20 nm, and thickness of the reflection film in the range of 80 to 160 nm.

Fig. 2



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Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] This invention relates to an optical recording medium especially suitable for application to a disc-shaped rewritable/reproducible optical recording medium.

Description of the Related Art

[0002] In recent data recording technologies, researches are being developed regarding optical recording systems. Optical recording systems can record and reproduce information signals without contacting a recording medium, and can attain higher recording densities as ten times or more as that those of magnetic recording systems. Additionally, optical recording systems have a number of advantages, including the availability for use with any type of memory such as reproduction-exclusive type, additional recording type and rewritable type. Thus, the optical recording systems are expected to be widely usable in industrial purposes and home-base purposes as a recording system that enables realization of inexpensive, large-capacity files.

[0003] Among those optical recording systems, optical magnetic discs and phase-versatile optical discs, for example, cope with rewritable memory modes. Optical magnetic discs are configured to locally heat a recording film made of a magnetic material to or above a Curie point or a temperature compensation point, thereby to decrease the coercive force of the recording medium, then apply an external recording magnetic field, thereby to change the magnetic orientation of the recording medium, and record information signals, or magnetically read out information signals. On the other hand, phase-versatile optical discs includes a recording film made of a phase -versatile material in which changes between a crystalline state and an amorphous state reversibly occur, and are configured to heat the recording film by irradiation of laser light, for example, thereby cause a change in phase in the recording film to record/erase information, or optically read out information signals.

[0004] As a conventional phase-versatile disc, DVD-RW (Digital Versatile Disc-Rewritable) is known and being spread. The format of DVD-RW is shown below.

Wavelength of light: 650 nm
Numerical aperture of the optical system lens:

For recording/erasure NA=0.60
For reproduction NA=0.60

Capacity: 4.7 GB
Track pitch: 0.74 μm
Reflectance: 18 through 30%
Modulation: 60% or more
Resolution: 15% or more
Linear velocity: 3.49 m/s
Repeatable recording frequency: 1000 times or more
Address: LPP system (a system that obtains it from a pre-pit provided on a land)

[0005] In order to realize such a phase-versatile optical disc under that regulation (specifically, DVD-RW), AgInSbTe-series materials are used as phase-versatile materials, and Al alloys are used as materials of reflection films.

[0006] The conventional phase-versatile discs, however, merely cope with recording with the linear velocity of 3.49 m/s , further improvements in recording speed and reproducing speed are demanded. When an improvement of the linear velocity is tried toward realization of high-speed recording and high-speed reproduction, the following problem will occur. That is, recording or reproduction of information signals at a higher linear velocity than the conventional linear velocity (3.49 m/s (equal speed)) will invite an increase of jitters and decrease of the modulation. Therefore, practically acceptable recording characteristics could not be obtained.

SUMMARY AND OBJECT OF THE INVENTION

[0007] It is therefore an object of the invention to provide an optical recording medium capable of preventing an increase of jitters and a decrease of the modulation even at a linear velocity higher than 3.49 m/s, and thereby ensuring

practically acceptable recording characteristics.

[0008] According to the first aspect of the invention, there is provided an optical recording medium comprising:

a substrate having corrugated and ridge-and-concavo-convex groove tracks on one major surface thereof; and
a first dielectric film, phase-versatile recording film, second dielectric film and reflection film that are sequentially stacked on one major surface of the substrate,
the phase change-versatile recording film being made of a GeInSbTe alloy material, and the reflection film being made of an AgPdCu alloy material,
in the GeInSbTe alloy material forming the phase change-versatile recording film, content of Ge being in the range from 1 weight % to 6 weight %, content of In being in the range from 2 weight % to 6 weight %, and ratio of Sb relative to Te being in the range of 2.4 times to 3.0 times, and in the AgPdCu alloy material forming the reflection film, content of Pd being in the range of 0.9 weight % to 1.5 weight %, and content of Cu being in the range of 0.9 weight % to 1.1 weight %,
depth of the furrow on the substrate having the groove tracks being in the range from 30 nm to 40 nm,
distance between two adjacent boundaries at opposite sides of the furrow being in the range of 0.27 μm to 0.33 μm, amplitude of the corrugation being in the range of 30 nm to 35 nm at 0-peak;
thickness of the first dielectric film being in the range of 65 nm to 80 nm, thickness of the phase change-versatile recording film being in the range of 12 nm to 18 nm, thickness of the second dielectric film being in the range of 12 nm to 20 nm, and thickness of the reflection film being in the range of 80 nm to 160 nm.

[0009] According to the second aspect of the invention, there is provided an optical recording medium comprising:

a substrate having corrugated and ridge-and-concavo-convex groove tracks on one major surface thereof; and
a first dielectric film, phase-versatile recording film, second dielectric film and reflection film that are sequentially stacked on the one major surface of the substrate,
the phase change-versatile recording film being made of a GeInSbTe alloy material, and the reflection film being made of an AlCu alloy material,
in the GeInSbTe alloy material forming the phase change-versatile recording film, content of Ge being in the range from 1 weight % to 6 weight %, content of In being in the range from 2 weight % to 6 weight %, and ratio of Sb relative to Te being in the range of 2.4 times to 3.0 times, and in the AlCu alloy material forming the reflection film, content of Cu being not more than 1.5 weight %,
depth of the furrow on the substrate having the groove tracks being in the range from 30 nm to 40 nm,
distance between two adjacent boundaries at opposite sides of the furrow being in the range of 0.27 μm to 0.33 μm, amplitude of the corrugation being in the range of 30 nm to 35 nm at 0-peak;
thickness of the first dielectric film being in the range of 65 nm to 80 nm, thickness of the phase change-versatile recording film being in the range of 12 nm to 18 nm, thickness of the second dielectric film being in the range of 12 nm to 20 nm, and thickness of the reflection film being in the range of 80 nm to 160 nm.

[0010] In the present invention, wavelength of light irradiated onto the phase change-versatile recording film of the optical recording medium upon recording or erasing information signal on or from the optical recording medium is typically in the range of 650 through 665 nm, approximately, and more specifically about 655 nm, taking compatibility with conventional recording/reproducing apparatuses into consideration.

[0011] In the present invention, numerical aperture of the lens in the optical system used upon recording or erasing information signals on or from the optical recording medium is typically in the range from 0.64 to 0.66, and numerical aperture of the lens in the optical system used upon reproducing information signals is typically in the range from 0.59 to 0.61. More specifically, numerical aperture of the lens in the optical system used upon recording or erasing information signals on or from the optical recording medium is approximately 0.65, and numerical aperture of the lens in the optical system used upon reproducing information signals is approximately 0.60.

[0012] In the present invention, the recording linear density in the optical recording medium is typically in the range from 0.2638 μm to 0.2694 μm per bit, and more specifically, the recording linear density in the optical recording medium is 0.267 μ m per bit.

[0013] In the present invention, the first dielectric film is made of a material with a low absorptance to laser light of the optical system used upon recording/reproduction to the optical recording medium. Preferably, a material having a value of extinction coefficient k not higher than 0.3 is used as the material of the first dielectric film.

[0014] In the present invention, the second dielectric film is made of a material with a low absorptance to laser light of the optical system used upon recording/reproduction of the optical recording medium. Preferably, a material having a value of extinction coefficient k not higher than 0.3 is used as the material of the first dielectric film.

[0015] In the present invention, the optical recording medium is a rewritable optical recording medium using a phase-

versatile material as the recording film. Specifically, it may be DVD+RW (Digital Versatile Disc + Rewritable).

[0016] According to the optical recording medium having the above-summarized configuration according to the invention, the phase change-versatile recording film in the optical recording medium is made of a GeInSbTe alloy material; the reflection film is made of an AgPdCu alloy material or AlCu alloy material; the GeInSbTe alloy material forming the phase change-versatile recording film contains Ge in the range from 1 weight % to 6 weight %, In in the range from 2 weight % to 6 weight %, and Sb in the range from 2.4 times to 3.0 times of Te; the AgPdCu alloy material forming the reflection film contains Pd in the range from 0.9 weight % to 1.5 weight % and Cu in the range from 0.9 weight % to 1.1 weight %; depth of each groove of the groove tracks on the major surface of the substrate is in the range from 30 nm to 40 nm; distance between two boundaries, among boundaries between lands and grooves of the groove tracks, is in the range from 0.27 μm to 0.33 μ m; thickness of the first dielectric film is in the range from 65 nm to 80 nm; thickness of the phase change-versatile recording film is in the range from 12 nm to 18 nm; thickness of the second dielectric film is in the range from 12 nm to 20 nm, and thickness of the reflection film is in the range from 80 nm to 160 nm. This configuration can prevent deterioration of jitters and a decrease of the modulation even when the linear velocity is increased upon recording and/or erasing information signals, and thereby ensures sufficient recording characteristics in the optical recording medium.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017]

Fig. 1 is a cross-sectional view that shows an optical disc prior to bonding according to the first embodiment of the invention;
Fig. 2 is a cross-sectional view that shows the optical disc according to the first embodiment of the invention;
Fig. 3 is a cross-sectional view that shows another optical disc after bonding according to the first embodiment of the invention;
Fig. 4 is a cross-sectional view of a disc substrate for explaining width and depth of a groove according to the first embodiment of the invention;
Fig. 5 is a graph for explaining definitions of characteristics regarding reflectance evaluated in the first embodiment of the invention;
Fig. 6 is a graph that shows a recording light emission pattern used upon evaluating jitter characteristics of the optical disc according to the first embodiment of the invention; and
Fig. 7 is a graph that shows DOW cycle dependencies of jitters and modulation of the optical disc according to the first embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0018] Embodiments of the invention are explained below with reference to the drawings . In all figures illustrating the embodiments, common and equivalent components are labeled with common reference numerals.

[0019] First explained is an optical recording medium according to the first embodiment of the invention. Fig. 1 shows the optical recording medium according to the first embodiment.

[0020] As shown in Fig. 1, the optical recording medium according to the first embodiment is made by bonding two phase-versatile disc-shaped recording mediums (hereafter called optical discs). The optical disc 1 prior to bonding is made up of a first dielectric film 3, phase-versatile recording film 4, second dielectric film 5, reflection film 6 and protective film 7 that are sequentially stacked on a major surface 2a of the disc substrate 2.

[0021] The disc substrate 2 is made of a plastic material such as polycarbonate resin, polyolefin resin, acrylic resin, or the like, or glass. Material of the disc substrate is selected from those that can pass at least laser light used for recording and reproducing information signals, and from the viewpoint of its cost, a plastic material is preferably used. Thickness of the disc substrate 2 is about 0.6 mm, for example. In the embodiment shown here, the major surface 2a of the disc substrate 2 has formed groove tracks as shown in Fig. 4, in which lands 10 and grooves 11 are alternately arranged in form of tracks. The track pitch is 0.74 μm, for example. Depth and width of the groove, as the groove conditions, are selected, taking it into consideration that they largely affect push-pull (PP) signals, as servo signals, and cross track (CT) signals. Specifically, groove depth is selected from the range of 30 to 40 mm, and the groove width is selected from the range of 0.27 to 0.33 μ m. With these values of the groove depth and groove width, a value of 0.28 to 0.56 is obtained as the pre-recording push-pull, and a value of 0.25 to 0.56 is obtained as the post-recording PP. Further, a value of 3% or more is obtained as the pre-recording cross track signal (CTS), and a value of 10% or more can be obtained as the post-recording CTS. The above-indicated groove width is defined by the width between two boundaries that are adjacent at opposite sides of a groove among boundaries of lands 10 and grooves 11. Specifically, as shown in Fig. 4, the width from the midpoint on the bank between a land 10 and a groove 11 to the midpoint

on the opposed bank between the adjacent land 10 and the same groove 11, that is, the value (A+B)/2 calculated from the width A of the bottom of the groove 11 and the distance B between adjacent two lands, is defined as the groove width. Conditions of the groove depth and groove width will be explained later in greater detail.

[0022] The groove tracks as shown in Fig. 4 have formed corrugated wobbling (not shown) for reading an address upon recording/reproducing information. Wobbling amplitude of the wobbling is chosen from the viewpoint of obtaining a sufficient wobble signal and preventing deterioration of the recording signal characteristics. That is, if the wobbling amplitude is determined to be less than 30 nm from 0 to a peak, sufficient wobble signal will not be obtained. If the wobbling amplitude is determined to be more than 35 nm, it will cause deterioration of recording signal characteristics in optical discs having the track pitch of 0.74 μm. Therefore, the wobbling amplitude of the disc substrate 2 according to the first embodiment is chosen from the range of 30 to 35 nm. Details about conditions of the wobbling amplitude will be explained later.

[0023] Materials of the first dielectric film 3 and the second dielectric film 5 are preferably those having a low. absorptance to laser light for recording and reproduction. They are preferably made of a material with a low absorptance , they are preferable, made of material unit an extinction coefficient k not larger than 0.3 to laser light used upon recording/reproduction. Taking heat resistance into consideration, $ZnS\text{-}SiO_2$ (especially having a molar ratio around 4:1), for example, is recommended. These first dielectric film 3 and second dielectric film 5 may be made of different ones of such materials.

[0024] Thickness of he first dielectric film 3 is determined from viewpoints of its reflectance and modulation. That is, if thickness of the first dielectric film 3 is out of the range from 65 nm to 80 nm, its reflectance will increase, and the modulation will decrease. Therefore, it is determined in the range from 65 to 80 nm, and in the first embodiment, it is 75 nm, for example. Details about conditions of thickness of the first dielectric film 3 will be explained later.

[0025] Regarding the second dielectric film 5, if its thickness is less than 12 nm, the phase change-versatile recording film 4 will be cooled rapidly, and the asymmetry property will deteriorate. On the other hand, if thickness of the second dielectric film 5 is thicker than 20 nm, its jitter characteristics will deteriorate, and desired property will not be obtained. Therefore, thickness of the second dielectric film 5 is preferably in the range from 12 nm to 20 nm. In the first embodiment, it is 16 nm, for example. Details about condition of the thickness of the second dielectric film 5 will be explained later.

[0026] The phase change-versatile film 4 is made of a GeInSbTe alloy, for example. Among compositions of the GeInSbTe alloy forming the phase change-versatile recording film 4, first regarding the content of Ge, if it is less than 1 weight %, storage stability will decrease. If its amount is more than 6 weight %, signal characteristics, especially the jitter characteristics, will decrease. Regarding the content of In, if it is less than 2 weight %, the phase change-versatile recording film 4 will be difficult to crystallize. If it is more than 6 weight %, reproduction stability will decrease, such as undesirable disappearance of recorded marks. Regarding the ratio of Sb relative to Te, if the value of Sb/Te is less than 2.4, signal characteristics will deteriorate in high-speed ranges of linear velocity. If it is more than 3.0, signal characteristics will deteriorate in low-speed ranges of linear velocity. Therefore, in the GeInSbTe alloy forming the phase change-versatile recording film 4, content of Ge is controlled in the range of 1 to 6 weight %, content of In is controlled in the range of 2 to 6 weight %, and Sb-to-Te ratio (Sb/Te) is controlled in the range of 2.4 through 3.0. In summary of these contents, when the composition of the phase change-versatile recording film 4 is $Ge_pIn_qSb_rTe_s$, composition ratios p, q, r and s (weight %) simultaneously satisfy the relations of $1 \le p \le 6$, $2 \le q \le 6$ and $2.4 \le r/s \le 3.0$. Details about composition conditions of materials forming the phase change-versatile recording film 4 will be explained later.

[0027] If the phase change-versatile recording film 4 is thinner than 12 nm, repetitive recording characteristics will seriously decrease. If its thickness is larger than 18 nm, modulation will seriously decrease too small to obtain desired characteristics. Therefore, thickness of the phase change-versatile recording film 4 is controlled in the range from 12 through 18 nm. In the first embodiment, it is 16 nm, for example.

[0028] The reflection film 6 is made of an Ag alloy, for example, and in the first embodiment, it may be made of an AgPdCu alloy. In the AgPdCu alloy forming the reflection film 6, first regarding the content of Pd, if it is higher than 1.5 weight % or lower than 0.9 weight %, resistance to corrosion will deteriorate. Also regarding the content of Cu, if it is less than 0.9 weight % or more than 1.1 weight %, resistance to corrosion will decrease. Therefore, in the AgPdCu alloy forming the reflection film 6 in the first embodiment, content of Pd is controlled in the range from 0.9 to 1.5 weight %, and content of Cu is controlled in the range of 0.9 to 1.1 weight %. Details about composition conditions of materials forming the reflection film 6 will be explained later.

[0029] As to the reflection film 6, if its thickness if thinner than 80 nm, heat generated in the phase change-versatile recording film 4 will not be able to diffuse sufficiently, and insufficient cooling will deteriorate the jitter characteristics. On the other hand, if the reflection film 6 is thicker than 160 nm, although not affecting thermal characteristics and optical characteristics, a stress produced in the reflection film 6 adversely affects mechanical characteristics such as skew, and disables obtaining desired characteristics. Therefore, thickness of the reflection film 6 is chosen from the range of 80 to 160 nm, and in the first embodiment, it may be 120 nm, for example.

[0030] The protective film 7 is made of an ultraviolet-setting resin, for example.

[0031] Then, two optical discs according to the first embodiment having the above-explained structure are prepared, and they are bonded together at their protective films 7 on the major surfaces 2a via an adhesive layer 8 to make up the optical disc according to the first embodiment. As shown in Fig. 3, it is also possible to use an optical disc made by bonding the optical disc according to the first embodiment and a dummy disc having a reflection film 9 and a protective film 7 sequentially stacked on a major surface 2a of a disc substrate 2 at their protective films 7 via an adhesive layer 8.

[0032] For recording information signals on the optical disc 1 according to the first embodiment having the above-explained structure, recording light such as laser light having a wavelength around 650 nm, for example, is locally irradiated from the other major surface 2b opposite from the major surface 2a of the disc substrate 2 to change a part of the phase change-versatile recording film 4 to a crystalline phase or amorphous phase. The phase change-versatile material made of GeInSbTe according to the first embodiment changes to an amorphous state when heated or cooled rapidly, and changes to a crystalline state when cooled gradually, for example, although depending upon the heating temperature. In this way, by making a crystal portion and an amorphous portion in the phase change-versatile recording film 4 in response to information signals, recording of the information signal is carried out. Recording bit length of the optical disc 1 according to the first embodiment is around 0.267 μm per bit, for example. Wavelength of the laser light used upon recording is about 650 nm, and numerical aperture NA is about 0.65. For recording in the first embodiment, the recording waveform shown in Fig. 6 is used.

[0033] For reproducing information signals recorded on the optical disc 1, reproduction light such as laser light is irradiated toward the phase change-versatile recording film 4 from the side of the other major surface 2b opposite from the major surface 2a of the disc substrate 2, thereby to carry out reproduction of information signals corresponding to the crystal phases and amorphous phases by using a difference in reflectance between different crystal phases or amorphous phases in the phase change-versatile recording film 4. Used as the reproduction light is laser light not to cause a phase change in the phase change-versatile recording film 4. Numerical aperture NA of the lens in the optical system used for reproduction is 0.60, for example.

[0034] Next explained is a manufacturing method of the optical recording medium according to the first embodiment, namely, the optical disc 1.

[0035] In the optical disc manufacturing method according to the first embodiment, first prepared is the disc substrate 2 having a thickness around 0.6 mm and made of a material permitting at least laser light to pass through, such as polycarbonate resin, polyolef in resin, acrylic resin or glass. Thereafter, tracking groove 11 is made in a spiral form.

[0036] After that, on the major surface 2a of the disc substrate 2 having formed the groove 11, ZnS-SiO_2 is stacked by sputtering, for example, to form the first dielectric film 3.

[0037] Thereafter, a GeInSbTe alloy is stacked as a phase-versatile material on the first dielectric film 3 by sputtering, for example, to form the phase change-versatile recording film 4.

[0038] At that time, in the step of making the phase change-versatile recording film by sputtering, a $Ge_pIn_qSb_rTe_s$ material is used as a target to satisfy the relations of $1 \leq p \leq 6$, $2 \leq q \leq 6$ and $2.4 \leq r/s \leq 3.0$. As this sputtering, simultaneous sputtering may be done by using a target of Ge, target of In, target of Sb and target of Te, or vacuum evaporation is also usable. By controlling the composition of those sputtering targets, phase-changing speed of the phase change-versatile recording film 4 can be increased, and the recording characteristics of the optical disc 1 at high linear velocities can be enhanced.

[0039] After that, ZnS-SiO_2, for example, is stacked on the second dielectric film 4 by sputtering, for example, to form the second dielectric film 5.

[0040] Subsequently, the AgPdCu alloy is stacked on the second dielectric film 5 by sputtering, for example, to form the reflection film 6 made of an AgPdCu alloy.

[0041] In the step of forming the reflection film 6 by sputtering, an AgPdCu alloy is used as a target, and composition ratios m and n (weight %) in the $Ag_lPd_mCu_n$ material are controlled to satisfy the relations of $0.9 \leq m \leq 1.5$ and $0.9 \leq n \leq 1.1$. As this sputtering, simultaneous sputtering may be employed by using a target of Ag, target of Pd and target of Cu simultaneously, or vacuum evaporation is also usable.

[0042] Next coated is an ultraviolet-setting resin, for example, on the reflection film 6 by spin coating, for example. As a result, the protective film 7 for protecting films of the disc substrate 2 is formed on the reflection film 6.

[0043] Finally, two such optical discs prepared in the above-explained process are prepared and bonded together at their protective films 7 with an adhesive, thereby to obtain the optical disc according to the first embodiment. Instead of two optical discs prepared as explained above, it is also possible to made up another type of optical disc by bonding the optical disc 1 prepared by the manufacturing method according to the first embodiment and a dummy disc having reflection film 9 and a protective film sequentially stacked on one major surface 2a of a disc substrate 2, putting their protective films 7 in contact with each other via an adhesive.

[0044] In this way, the optical disc 1 according to the first embodiment is obtained.

[0045] Experiments were carried out concerning optical discs according to the first embodiment, together with experiments about optical discs out of conditions of those according to the first embodiment.

[0046] First made is the first experiment regarding relations between groove conditions including groove depth,

groove width and wobbling amplitude and NWS (normalized wobble signal), PP (push-pull magnitude) and CTS (cross track signal).

[0047] That is, in the first experiment, disc substrates different in groove condition were prepared, and a first dielectric film, phase-versatile recording film, second dielectric film and reflection film were sequentially stacked in the same manufacturing process as that of the first embodiment on one major surface of each disc substrate having formed grooves. Then, after initialization or formatting, NWS, PP and CTS were measured. At the same time, recording was carried out under optimized recording strategy and recording power, and PP and CTS after recording were measured. Wavelength of the laser light in a measurement/evaluation apparatus used for the first experiment was 650 nm, and NA was 0.65. Recording density of the optical disc was 0.267 μm per bit.

[0048] Results of the first experiment are shown in Table 1 below. Ranges of numerical values indicated under the items, NWS, PP and CTS, are their standard ranges. In the items of PP and CTS, standard values before and after recording are shown together. When each evaluation result about NWS, PP and CTS is in the standard range, "O" is indicated, and if it is out of the standard range, "X" is indicated.

TABLE 1

Groove depth (nm)	Groove width (μm)	Wobbling amplitude (nm)	NWS 0.2-0.3	PP before 0.28-0.56 after 0.25-0.56	CTS before >0.03 after >0.1
30	0.23	35	O	O	O
30	0.27	35	O	O	O
30	0.33	35	O	O	O
25	0.29	35	X	O	X
30	0.29	35	O	O	O
35	0.29	35	O	O	O
40	0.29	30	O	O	O
45	0.29	30	O	X	O
35	0.28	25	X	O	O
35	0.28	30	O	O	O
35	0.28	35	O	O	O
35	0.28	40	X	O	O

[0049] As apparent from Table 1, when the groove width is optimized to 0.29 μm, and the groove depth is changed variously in the range from 25 to 45 nm, NWS and CTS come out of the standard ranges when the groove depth is 25 nm or less, below 30 nm, and PP comes out of the standard range when the groove depth is 45 nm or more, beyond 40 nm. When the groove depth is 30 nm, 35 nm and 40 nm (30 to 40 nm), NWS as well as PP and CTS before and after recording come within the standard ranges . Therefore, groove depth should be selected from the range larger than 25 nm and smaller than 45 nm, and more preferably from the range of 30 to 40 nm.

[0050] Still referring to Table 1, also when the groove depth is optimized to 30 nm or 35 nm, and the groove width is changed variously in the range of 0.23 to 0.33 μm, NWS as well as CTS and PP before and after recording come within the standard ranges. Therefore, groove width should be chosen from the range of 0.23 to 0.33 μm, and more preferably from the range of 0.27 to 0.33 μm.

[0051] Still referring to Table 1, when the groove depth and the groove width are optimized to 30 nm (or 35 nm) and 0.29 μm (or 0.28 μm), respectively, and wobbling amplitude is changed variously in the range of 25 to 40 nm, NWS comes out of the standard range when the wobbling amplitude becomes 25 nm below 30 nm, or 40 mm beyond 35 nm. When the wobbling amplitude is 30 nm and 35 nm, all of NWS, PP and CTS before and after recording come within the standard ranges. Therefore, wobbling amplitude should be selected from the range larger than 25 nm and smaller than 40 nm, and more preferably from the range of 30 to 35 nm.

[0052] Next made was the second experiment regarding dependencies of signal characteristics of optical discs upon film thickness of the first dielectric film, phase-versatile recording film, second dielectric film and reflection film.

[0053] That is, in the second experiment, the first dielectric film, phase-versatile recording film, second dielectric film and reflection film were formed on each disc substrate, variously changing these films in thickness to obtain optical discs. After that, recording characteristics of these various optical discs were evaluated. In the second experiment,

evaluation was made at two kinds of linear velocities for recording, namely, 3.49 m/s (equal velocity) and 8.44 m/s (2.5-times velocity). The measurement/evaluation apparatus and recording densities of optical discs used in the second experiment were the same as those of the first experiment, and the recording strategy and the recording power were optimized.

[0054] Results of the second experiment are shown in Table 2 below. In the second experiment, I_{14h} (higher reflectance level of 14T signals recorded in the groove. See Fig. 5), modulation (I_{14}/I_{14h}. See Fig. 5), resolution (I_3/I_{14h}. See Fig. 5), asymmetry (deviation between the center of I_3 and the center of I_{14}. See Fig. 5), and clock-to-jitter characteristics were measured while variously changing the films forming optical discs in thickness. Ranges of numerical values indicated under the items are their standard ranges, setting conditions enabling reproduction with conventional optical disc reproduction-exclusive apparatuses (for example, DVD-ROM drives). That is, I_{14h} in the range of 18 through 30%, modulation not lower than 60%, resolution not lower than 15%, asymmetry in the range of -5 to 15%, and jitters not higher than 10% are regarded to be within the standard ranges. When each evaluation result of I_{14h}, modulation, resolution, asymmetry and 3T jitters falls within the standard range, "O" is indicated, and if it is out of the standard range, "X" is indicated.

TABLE 2

1st dielectric film	Phase-Versatile Recording film	2nd dielectric film	Reflective film	I_{14h} 0.18-0.30	Modulation >0.6	Resolution >0.15	Asymmetry -0.05-0.15	Jitter <10%
60	15	16	120	X	O	O	O	O
65	15	16	120	O	O	O	O	O
80	15	16	120	O	O	O	O	O
85	15	16	120	O	X	X	X	X
75	10	16	120	X	X	X	O	O
75	12	16	120	O	O	O	O	O
75	18	16	120	O	O	O	O	O
75	21	16	120	O	O	O	O	X
75	15	10	120	O	X	X	X	X
75	15	12	120	O	O	O	O	O
75	15	20	120	O	O	O	O	O
75	15	24	120	X	O	O	X	X
75	15	16	50	O	X	X	X	X
75	15	16	80	O	O	O	O	O
75	15	16	160	O	O	O	O	O

[0055] As apparent from Table 2, when thickness of the first dielectric film is changed variously in the range from 60 to 85 nm while optimizing thickness of the other films, I_{14h} comes out of the standard range when the thickness is 60 nm, below 65 nm, and all items other than I_{14h} come out of the standard ranges when the thickness is 85 nm, beyond 80 nm. When thickness of the first dielectric film is 65 nm, 75 nm and 80 nm (65 to 80 nm), all characteristics come within the standard ranges. Therefore, thickness of the first dielectric film should be chosen from the range larger than 60 nm and less than 85 nm, and more preferably from the range of 65 to 80 nm.

[0056] Still referring to Table 2, in case that thickness of the phase change-versatile recording film is changed variously in the range of 10 to 21 nm while the first dielectric film is optimized to 75 nm, when the thickness is 10 nm below 12 nm, I_{14h}, resolution and modulation come out of the standard ranges. When thickness of the phase change-versatile recording film is 21 nm, jitters come out of the standard range. When thickness of the first dielectric film is optimized to 75 nm and thickness of the phase change-versatile recording film is changed to 12 nm and 18 nm, all items come within the standard ranges. Therefore, thickness of the phase change-versatile recording film should be selected from the range larger than 10 nm and smaller than 21 nm, and more preferably from the range of 12 to 18 nm.

[0057] Still referring to Table 2, when the first dielectric film and the phase change-versatile recording film are optimized in thickness to 75 nm and 15 nm, respectively, and thickness of the second dielectric film is changed variously in the range of 10 to 24 nm, all items other than I_{14h} come out of the applicable ranges when thickness of the second dielectric film is 10 nm below 12 nm. When thickness of the second dielectric film is 24 nm beyond 20 nm, I_{14h}, asymmetry and jitters come out of the standard ranges. Further, when thickness of the second dielectric film is 12 nm and 20 nm, all items come in the standard ranges. Therefore, thickness of the second dielectric film should be selected from the range larger than 10 nm and smaller than 24 nm, and more preferably from the range of 12 to 20 nm.

[0058] Still referring to Table 2, when the first dielectric film, phase-versatile recording film and second dielectric film are optimized in thickness to 75 nm, 15 nm and 16 nm, respectively, and thickness of the reflection film is changed variously in the range of 50 to 160 nm, all items other than I_{14h} come out of the standard ranges when thickness of the reflection film is 60 nm below 80 nm. When thickness of the reflection film is 50 nm and 160 nm, values of all items come within the standard ranges. Therefore, thickness of the reflection film should be larger than 50 nm, and preferably selected from the range of 80 to 160 nm.

[0059] Next made was the third experiment regarding dependencies of signal characteristics of optical discs upon compositions of materials forming the phase change-versatile recording film.

[0060] In the third experiment, the first dielectric film, phase-versatile film, second dielectric film and reflective are formed on each disc substrate, changing compositions of the phase change-versatile recording films variously, to make up optical discs. After that, under two kinds of linear velocities for recording, namely, 3.49 m/s (equal velocity) and 8.44 m/s (2.5-times velocity), jitter characteristics were evaluated with these various optical discs. For both those two kinds of linear velocities, only when jitter characteristics were evaluated to be good, optical discs after recording were held for 100 hours in an atmosphere held at the temperature of 80°C and humidity of 85%, and evaluation was carried out thereafter to confirm whether reproduction characteristics of these optical discs deteriorated, that is, whether they were acceptable in storage stability. The measurement/evaluation apparatus and recording densities of optical discs used in the third experiment were the same as those of the first experiment, and the recording strategy and the recording power were optimized.

[0061] Results of the third experiment are shown in Table 3 below. In the third experiment, measurement was carried out with various optical discs different in composition of the phase change-versatile recording films. The range of numerical values under the item of jitter indicates the standard range. That is, jitters of 10% or less are within the standard range. When each evaluation result about jitters falls within the standard range, that is, in the range not higher than 10%, "O" is indicated, and if it is out of the standard range, i.e. in excess of 10%, "X" is indicated. Regarding storage stability, when it deteriorates, "X" is indicated, and when no deterioration or changes occurs, "O" is indicated.

TABLE 3

Ge weight %	In Weight %	Sb/Te -	Jitter 1x <10%	Jitter 2.5x <10%	Storage stability
0	3	2.5	O	O	X
1	3	2.5	O	O	O
6	3	2.7	O	O	O
7	3	2.7	X	X	-
2	0	2.5	X	X	-
2	2	2.5	O	O	O
4	6	2.7	O	O	O

TABLE 3 (continued)

Ge weight %	In Weight %	Sb/Te -	Jitter 1x <10%	Jitter 2.5x <10%	Storage stability
4	8	2.7	X	O	-
2	4	2	O	X	-
2	4	2.4	O	O	O
4		4 3	O	O	O
4	4	3.4	X	O	-

[0062] As apparent from Table 3, while the content (composition ratio) of Ge is changed variously in the range of 0 to 7 weight %, when the composition ratio of Ge is 0 weight %, storage stability is bad, and optical discs deteriorate. When the composition ratio of Ge is 7 weight % beyond 6 weight %, under any of the linear velocities, namely 2.5-times velocity and equal velocity, jitter comes out of the standard range. When the composition ratio of Ge is changed to 1 weight %, 2 weight %, 4 weight % and 6 weight %, as far as the other composition ratios are optimized, all characteristics come within the standard ranges. Therefore, composition ratio of Ge should be selected from the range larger than 0 weight % and smaller than 7 weight %, and more preferably from the range of 1 to 6 weight %.

[0063] Still referring to Table 3, when the composition ratio is optimized to 2 weight % or 4 weight %, and composition ratio of In is changed variously in the range of 0 to 8 weight %, jitter comes out of the standard range under any of the linear velocities, 2.5-times velocity and equal velocity, when the composition ration of In is 0 weight %. When the composition ration of In is 8 weight % beyond 6 weight %, jitter at the four-times linear velocity comes out of the standard range. In the case where the composition ratio of Ge is optimized to 2 weight % or 4 weight %, and composition ratio of In is changed to 2 weight %, 3 weight %, 4 weight % and 6 weight %, respectively, all items come within the standard ranges. Therefore, composition ratio of In should be selected from the range larger than 0 weight % and smaller than 8 weight %, and more preferably from the range of 2 to 6 weight %.

[0064] Still referring to Table 3, when composition ratios of Ge and In are optimized to 2 weight % (or 4 weight %) and 4 weight %, and the ratio Sb/Te is changed variously in the range of 2 to 3.4, under the Sb/Te ratio smaller than 2.4, jitter at the linear velocity of 2.5-times velocity comes out of the standard range. When the Sb/Te ratio is 3.4 beyond 3.0, jitter at the equal linear velocity comes out of the standard range. In the case where composition ratios of Ge and In are optimized and the Sb/Te ratio is set to 2.4 and 3.0, evaluated values of all items come within the standard ranges. Therefore, Sb/Te ratio should be selected from the range larger than 2 and smaller than 3.4, and more preferably from the range of 2.4 to 3.0.

[0065] Next made was the fourth experiment about dependencies of resistance to corrosion and signal characteristics of optical discs upon composition of the reflection film.

[0066] In the fourth experiment, the first dielectric film, phase-versatile recording film and second dielectric film were formed on each disc substrate. After that, reflection films with various composition ratios were stacked on the second dielectric films, thereby to obtain optical discs. Thereafter, jitter characteristics were evaluated with these various optical discs under the recording linear velocity of 3.49 m/s (equal velocity). Additionally, these optical discs were stored for 100 hours in an atmosphere at the temperature of 80°C and the humidity of 85%, and evaluation was carried out to confirm whether any corrosion occurred on surfaces of the reflection films, i.e. , whether resistance to corrosion is good or not. The measurement/evaluation apparatus and recording densities of optical discs used in the fourth experiment were the same as those of the first experiment, and the recording strategy and the recording power were optimized.

[0067] Results of the fourth experiment are shown in Table 4 below. In the fourth experiment, optical discs variously changed in composition ratio of the AgPdCu alloy forming the reflection films were measured. The range of numerical values under the item of jitter indicates the standard range. That is, jitters of 10% or less are within the standard range. When each evaluation result about jitters falls within the standard range, "O" is indicated, and if it is out of the standard range, i.e. in excess of 15%, "X" is indicated. Regarding resistance to corrosion, when there is corrosion, "X" is indicated, and when there is no corrosion, "O" is indicated.

TABLE 4

Al weight %	Ag weight %	Pd weight %	Cu weight %	anti-corrosion	Jitter 1x <10%
-	100	-	-	x	O
-	balance	0.5	1	O	O
-	balance	0.9	1	O	O

TABLE 4 (continued)

Al weight %	Ag weight %	Pd weight %	Cu weight %	anti-corrosion	Jitter 1x <10%
-	balance	1.5	1	O	O

[0068] As apparent from Table 4, only when the composition ratio of Ag is 100 weight %, corrosion occurs. Otherwise, whichever composition ratio the reflection film has, jitter comes within the standard range. That is, when Pd and Cu are added to Ag, corrosion does not occur, and resistance corrosion is enhanced. Therefore, the reflection film should be made of an AgPdCu alloy, preferably having the composition ratio of Pd in the range of 0.5 to 1.5 weight %, and preferably in the range of 0.9 to 1.5 weight %, and having the composition ratio of Cu in the range of 0.9 to 1.1 weight % near 1 weight %.

[0069] Next made was the fifth experiment about relations of DOW (Direct Over Write) characteristics with jitters and modulation.

[0070] In the fifth experiment, similarly to the first embodiment, the 75 nm thick first dielectric film 3, 16 nm thick phase-versatile recording film 4, 15 nm thick second dielectric film 5 and 120 nm thick reflection film 6 were formed on each disc substrate 2 to make up optical discs 1. Then, information signals were recorded on the optical discs 1 at the linear velocity of 3.49 m/s (equal velocity) . Additionally, information signals were recorded on similar optical discs 1 at the linear velocity of 8.44 (2.5-times velocity). Furthermore, under these two linear velocities, overwrite was repeated, and jitter characteristics and modulation were evaluated. The measurement/evaluation apparatus and recording densities of optical discs used in the fifth experiment were the same as those of the first experiment, and the recording strategy and the recording power were optimized.

[0071] Results of the fifth experiment are shown in Fig. 7. Fig. 7 shows dependencies of jitter values upon DOW cycles at the linear velocity of 3.49 m/s (equal velocity) (white circle "○" and solid line "—") and at the linear velocity of 8.44 m/s (2.5-times velocity) (black round mark "●" and solid line "—"), and dependencies of modulation upon DOW cycles at the linear velocity of 3.49 m/s (equal velocity) (white square "□" and broken line "--") and at the linear velocity of 8.44 m/s (2.5-times velocity) (black square mark "■" and broken line "--".

[0072] As shown in Fig. 7, at both linear velocities, 3.49 m/s and 8.44 m/s, it was confirmed that jitter became less than 10% when repetitive recording frequencies reached 1000 times and that sufficient recording characteristics could be ensured. Additionally, it was also confirmed from Fig. 7 that, at both linear velocities, i.e. equal velocity and 2.5-time velocity, modulation kept values not lower than 60% even when DOW cycle frequencies increased to 10^4 times and it did not change substantially.

[0073] From these results, optical discs according to the first embodiment were confirmed to be able to record and reproduce information while maintaining sufficient recording characteristics at both linear velocities in the range from 3.49 m/s to 8.44 m/s.

[0074] As explained above, according to the first embodiment, the phase change-versatile recording film 4 in the optical disc 1 is made of a GeInSbTe alloy material; the reflection film is made of an AgPdCu alloy material; the GeInSbTe alloy material forming the phase change-versatile recording film 4 contains Ge in the range from 1 to 6 weight %, In in the range from 2 to 6 weight %, and Sb in the range from 2.4 to 3.0 times of Te; the AgPdCu alloy material forming the reflection film 6 contains Pd in the range from 0.9 to 1.5 weight % and Cu in the range from 0.9 to 1.1 weight %; groove depth is in the range from 30 nm to 40 nm; groove width is in the range from 0.27 to 0.33 μm; thickness of the first dielectric film 3 is in the range from 65 to 80 nm; thickness of the phase change-versatile recording film 4 is in the range from 12 to 18 nm; thickness of the second dielectric film 5 is in the range from 12 to 20 nm, and thickness of the reflection film 6 is in the range from 80 to 160 nm. Therefore, it is possible to perform recording and reproduction while maintaining characteristics of the standard of conventional phase-versatile optical discs (wavelength of laser light: 650 nm; track pitch: 0.74 μm, (during reproduction, NA: 0.60; reflectance (I_{14h}): 18 to 30%: modulation: 60% or more; resolution: 15% or more); (during and before recording, NWS: 0.2 through 0.3; NA: 0.65; repetitive recording frequency: 1000 times or more)) even when the linear velocity is 8.44 m/s not lower than 3.49 m/s. Therefore, CAV recording and reproduction are possible. As a result, the optical disc according to the first embodiment can be reproduced with a conventional optical disc reproduction-exclusive apparatus (for example, DVD-ROM drive).

[0075] Next explained is an optical disc according to the second embodiment. In the optical disc according to the second embodiment, unlike the first embodiment, the reflection film 6 is made of an AlCu alloy. Content of Cu in the AlCu alloy is controlled in the range not higher than 1.5 weight %, and more specifically, to 1 weight %, for example. The other configuration of the optical disc according to the second embodiment is the same as the first embodiment, and its explanation is omitted here.

[0076] Using the optical disc according to the second embodiment, the sixth experiment was conducted about resistance to corrosion of the reflection film and dependency of signal characteristics upon composition of the reflection film.

[0077] In the sixth embodiment, similarly to the manufacturing method according to the first embodiment, the first dielectric film, phase-versatile recording film and second dielectric film were first formed on each disc substrate. Thereafter, reflection films made of AlCu alloys different in composition were stacked on the second dielectric films to make up optical discs. After that, with these various optical discs, jitter characteristics were evaluated at the recording linear velocity of 3.49 m/s (equal velocity). Further, these optical discs were stored for 100 hours in an atmosphere controlled at the temperature of 80°C and the humidity of 85%, evaluation was made to confirm whether erosion occurred on surfaces of the reflection films, that is, whether the optical discs were good in resistance to corrosion. The measurement/evaluation apparatus and recording densities of optical discs used in the sixth experiment were the same as those of the first experiment, and the recording strategy and the recording power were optimized.

[0078] Results of the sixth experiment are shown in Table 5 below. In the sixth experiment, measurement was conducted with optical discs changed variously in composition of the AlCu alloy forming the reflection films. The range of numerical values under the item of jitter indicates the standard range. That is, jitters of 10% or less are within the standard range. When each evaluation result about jitters falls within the standard range, that is, in the range not higher than 10%, "O" is indicated, and if it is out of the standard range, i.e. in excess of 10%, "X" is indicated. Regarding resistance to corrosion, when there is corrosion, "X" is indicated, and when there is no corrosion, "O" is indicated.

TABLE 5

Al weight %	Ag weight%	Pd weight%	Cu weight%	Anti-corrosion	Jitter 1x <10%
Balance	-	-	1	O	O
Balance	-	-	1.5	O	O
Balance	-	-	2	O	X

[0079] As apparent from Table 5, when the content of Cu forming the reflection film is 2 weight %, jitter comes out of the standard range, and when the content is 1.5 % and 1 % below 2 weight %, jitter comes within the standard range. Further, regardless of the content of Cu, corrosion does not occur, and good resistance to corrosion is obtained. Therefore, the reflection film 6 according to the second embodiment should be made of an AlCu alloy containing Cu in the range not higher than 2 weight %, and more preferably in the range not higher than 1.5 weight %.

[0080] The second embodiment, which is the same as the first embodiment except the reflection film 6 made of an AlCu alloy, ensures the same effects as those of the first embodiment.

[0081] Although the invention has been explained with reference to specific embodiments, the invention is not limited to these embodiments, but can be modified in various modes within the technical concept of the invention.

[0082] For example, film deposition methods and materials of disc substrates and protective films proposed in the foregoing embodiments are not but mere examples, and different film deposition methods maybe used, if necessary, and the disc substrate and the protective film may be made of other materials.

[0083] Although the first and second embodiments have been explained as using $ZnS\text{-}SiO_2$ as the material of the first dielectric film and the second dielectric film, any other material may be used provided the extinction coefficient k is not larger than 0.3. More specifically, usable as materials of the first dielectric film and the second dielectric film are materials made of, or containing as a major component, nitrides, oxides, carbides, fluorides, sulfides, nitric oxides, nitric carbides or oxycarbides of metals or semi-metals like Al, Si, Ta, Ti, Zr, Nb, Mg, B, Zn, Pb, Ca, La, Ge, and so on. More specifically, usable as materials of the first dielectric film 3 and the second dielectric film 5 are AlN_x ($0.5 \le x \le 1$, especially AlN), Al_2O_{3-x} ($0 \le x \le 1$ (especially Al_2O_3)), Si_3N_{4-x} ($0 \le x \le 1$ (especially Si_3N_4)), SiO_x ($1 \le x \le 2$ (especially SiO_2, SiO), MgO, Y_2O_3, $MgAl_2O_4$, TiO_x ($1 \le x \le 2$, especially TiO_2)), $BaTiO_3$, $SrTiO_3$, Ta_2O_{5-x} ($0 \le x \le 1$ (especially Ta_2O_5)), GeO_x ($1 \le x \le 2$), SiC, ZnS, PbS, Ge-N, Ge-N-O, Si-N-O, CaF_2, LaF, MgF_2, NaF, TiF_4, and so on, or materials containing them as their major components, or mixtures of these materials, such as $AlN\text{-}SiO_2$, for example.

[0084] As explained above, according to the first aspect of the invention, the phase change-versatile recording film is made of a GeInSbTe alloy material; the reflection film is made of an AgPdCu alloy material; the GeInSbTe alloy material forming the phase change-versatile recording film contains Ge in the range from 1 weight % to 6 weight %, In in the range from 2 weight % to 6 weight %, and Sb in the range from 2.4 to 3.0 times of Te; the AgPdCu alloy material forming the reflection film contains Pd in the range from 0.9 weight % to 1.5 weight % and Cu in the range from 0.9 weight % to 1.1 weight %; groove depth in the groove track corrugation is in the range from 30 nm to 40 nm; distance between two boundaries, among boundaries between lands and grooves of the groove tracks, is in the range from 0.27 μm to 0.33 μm; thickness of the first dielectric film is in the range from 65 to 80 nm; thickness of the phase change-versatile recording film is in the range from 12 to 18 nm; thickness of the second dielectric film is in the range from 12 to 20 nm, and thickness of the reflection film is in the range from 80 to 160 nm. Therefore, it is possible to ensure recording and reproduction characteristics based on the conventional standard, with Na during recording being 0.65 and NA during reproduction being 0.60, therefore enable reproduction with reproduction-exclusive apparatuses

in accordance with the conventional standard, prevent deterioration of jitter and decrease of modulation even at the linear velocity of 3.49 through 8.44 m/s, and thereby obtain an optical recording medium ensuring practically sufficient recording/reproducing properties. Additionally, according to the invention, an optical recording medium available for reproduction with conventional optical disc reproduction-exclusive apparatuses can be obtained.

[0085] According to the second aspect of the invention, the phase change-versatile recording film is made of a GeInSbTe alloy material; the reflection film is made of an AlCu alloy material; the GeInSbTe alloy material forming the phase change-versatile recording film contains Ge in the range from 1 weight % to 6 weight %, In in the range from 2 weight % to 6 weight %, and Sb in the range from 2.4 to 3.0 times of Te; the AlCu alloy material forming the reflection film contains Cu not exceeding 1.5 weight %; groove depth in the groove track corrugation is in the range from 30 nm to 40 nm; distance between two boundaries, among boundaries between lands and grooves of the groove tracks, is in the range from 0.27 μm to 0.33 μm; thickness of the first dielectric film is in the range from 65 to 80 nm; thickness of the phase change-versatile recording film is in the range from 12 to 18 nm; thickness of the second dielectric film is in the range from 12 to 20 nm, and thickness of the reflection film is in the range from 80 to 160 nm. Therefore, it is possible to ensure recording and reproduction characteristics based on the conventional standard, with NA during recording being 0.65 and NA during reproduction being 0.60, therefore enable reproduction with reproduction-exclusive apparatuses in accordance with the conventional standard, prevent deterioration of jitter and decrease of modulation even at the linear velocity of 3.49 through 8.44 m/s, and thereby obtain an optical recording medium ensuring practically sufficient recording/reproducing properties. Additionally, according to the invention, an optical recording medium available for reproduction with conventional optical disc reproduction-exclusive apparatuses can be obtained.

Claims

1. An optical recording medium comprising:

   a substrate having corrugated and ridge-and-concavo-convex groove tracks on one major surface thereof; and
   a first dielectric film, phase-versatile recording film, second dielectric film and reflection film that are sequentially stacked on the one major surface of said substrate,
   said phase-versatile recording film being made of a GeInSbTe alloy material, and said reflection film being made of an AgPdCu alloy material,
   in said GeInSbTe alloy material forming said phase-versatile recording film, content of Ge being in the range from 1 weight % to 6 weight %, content of In being in the range from 2 weight % to 6 weight %, and ratio of Sb relative to Te being in the range of 2.4 times to 3.0 times, and in said AgPdCu alloy material forming said reflection film, content of Pd being in the range of 0.9 weight % to 1.5 weight %, and content of Cu being in the range of 0.9 weight % to 1.1 weight %,
   depth of the furrow on said substrate having said groove tracks being in the range from 30 nm to 40 nm,
   distance between two adjacent boundaries at opposite sides of said furrow being in the range of 0.27 μm to 0.33 μm,
   amplitude of said corrugation being in the range of 30 nm to 35 nm at 0-peak;
   thickness of said first dielectric film being in the range of 65 nm to 80 nm, thickness of said phase-versatile recording film being in the range of 12 nm to 18 nm, thickness of said second dielectric film being in the range of 12 nm to 20 nm, and thickness of said reflection film being in the range of 80 nm to 160 nm.

2. The optical recording medium according to claim 1 wherein wavelength of light irradiated onto said phase-versatile recording film on said optical recording medium upon execution of recording and/or erasure of information signal on or from said optical recording medium is in the range from 650 nm to 665 nm.

3. The optical recording medium according to claim 1 wherein numerical aperture of a lens of an optical system used upon recording and/or erasing information signals on or from the optical recording medium is in the range from 0.64 to 0.66, and numerical aperture of a lens of an optical system used for reproducing information signals is in the range from 0.59 to 0.61.

4. The optical recording medium according to claim 1 wherein recording linear density of said optical recording medium is in the range from 0.2638 μm to 0.2694 μm per bit.

5. An optical recording medium comprising:

   a substrate having corrugated and ridge-and-concavo-convex groove tracks on one major surface thereof; and

a first dielectric film, phase-versatile recording film, second dielectric film and reflection film that are sequentially stacked on said one major surface of said substrate,
said phase-versatile recording film being made of a GeInSbTe alloy material, and said reflection film being made of an AlCu alloy material,
in said GeInSbTe alloy material forming said phase-versatile recording film, content of Ge being in the range from 1 weight % to 6 weight %, content of In being in the range from 2 weight % to 6 weight %, and ratio of Sb relative to Te being in the range of 2.4 times to 3.0 times, and in said AlCu alloy material forming said reflection film, content of Cu being not more than 1.5 weight %,
depth of the furrow on said substrate having said groove tracks being in the range from 30 nm to 40 nm,
distance between two adjacent boundaries at opposite sides of said furrow being in the range of 0.27 μm to 0.33 μm,
amplitude of said corrugation being in the range of 30 nm to 35 nm at 0-peak;
thickness of said first dielectric film being in the range of 65 nm to 80 nm, thickness of said phase-versatile recording film being in the range of 12 nm to 18 nm, thickness of said second dielectric film being in the range of 12 nm to 20 nm, and thickness of said reflection film being in the range of 80 nm to 160 nm.

6. The optical recording medium according to claim 5 wherein wavelength of light irradiated onto said phase-versatile recording film on said optical recording medium upon execution of recording and/or erasure of information signal on or from said optical recording medium is in the range from 650 nm to 665 nm.

7. The optical recording medium according to claim 5 wherein numerical aperture of a lens of an optical system used upon recording and/or erasing information signals on or from the optical recording medium is in the range from 0.64 to 0.66, and numerical aperture of a lens of an optical system used for reproducing information signals is in the range from 0.59 to 0.61.

8. The optical recording medium according to claim 5 wherein recording linear density of said optical recording medium is in the range from 0.2638 μm to 0.2694 μm per bit.

Fig. 1

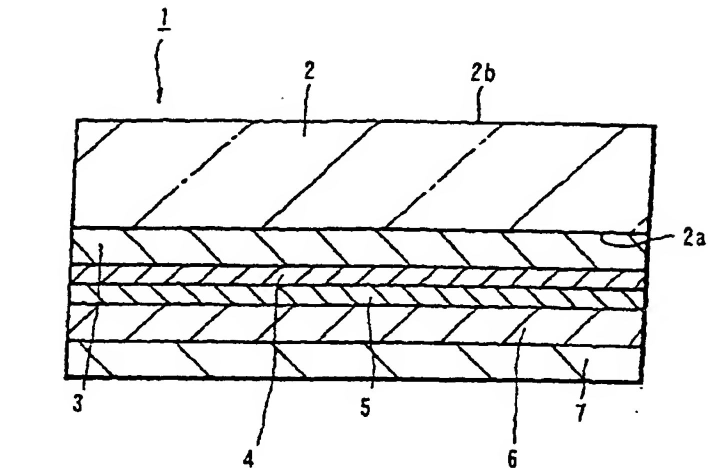


Fig. 2

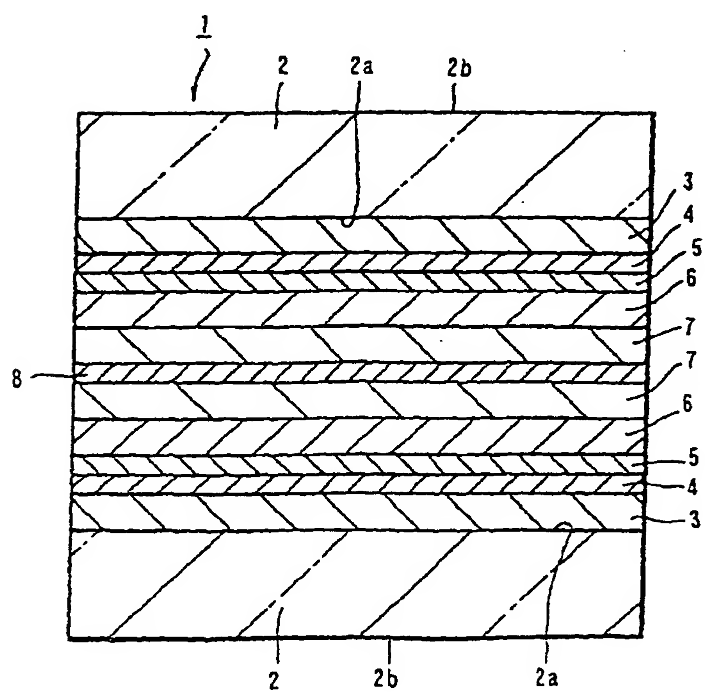


Fig. 3

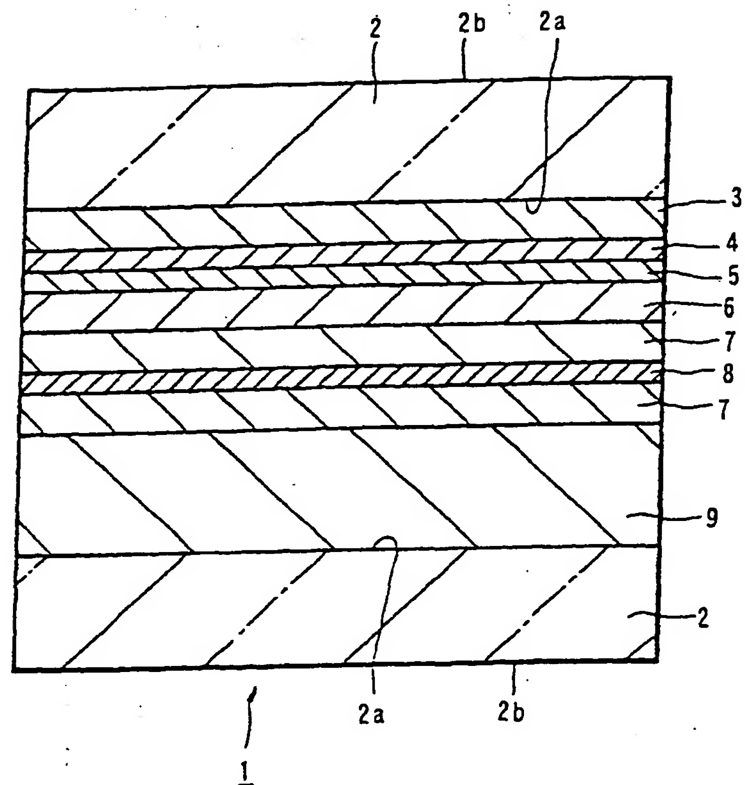


Fig. 4

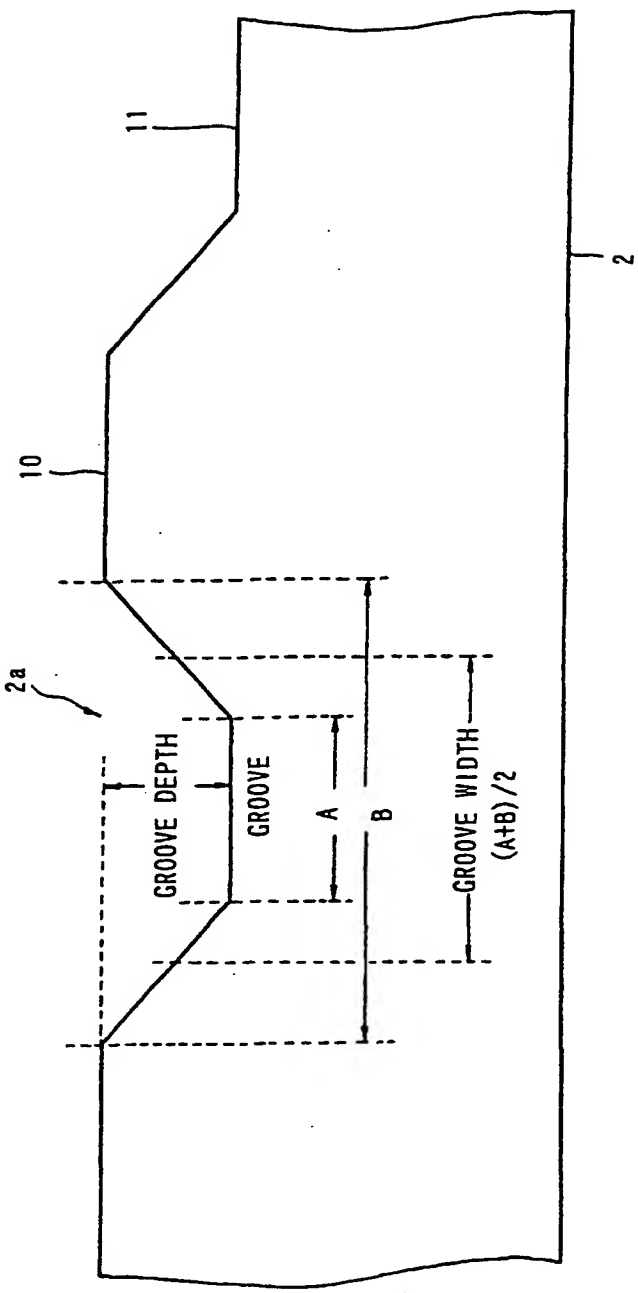


Fig. 5

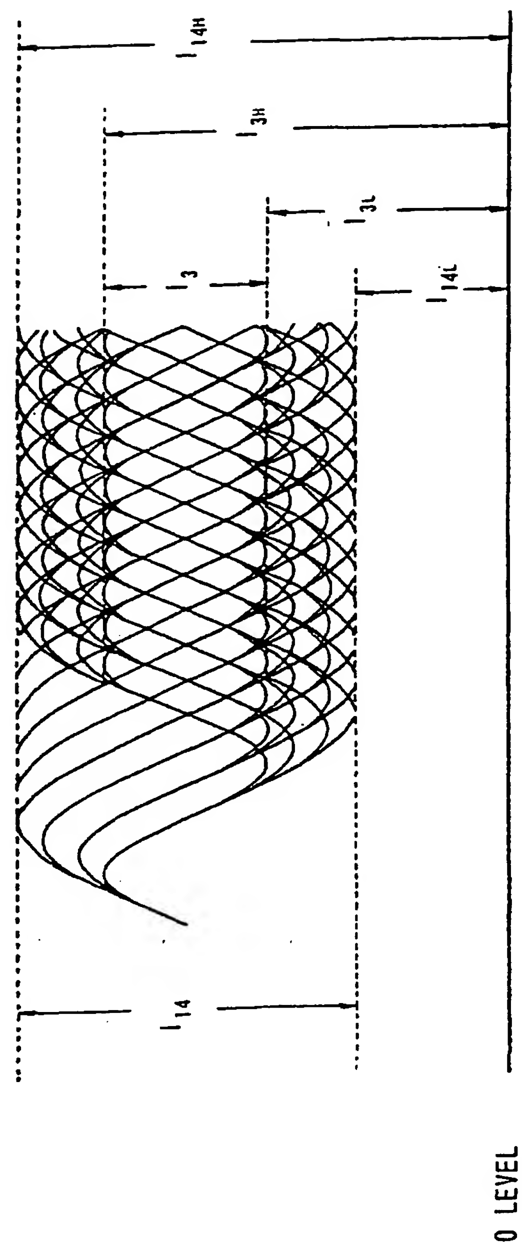


Fig. 6

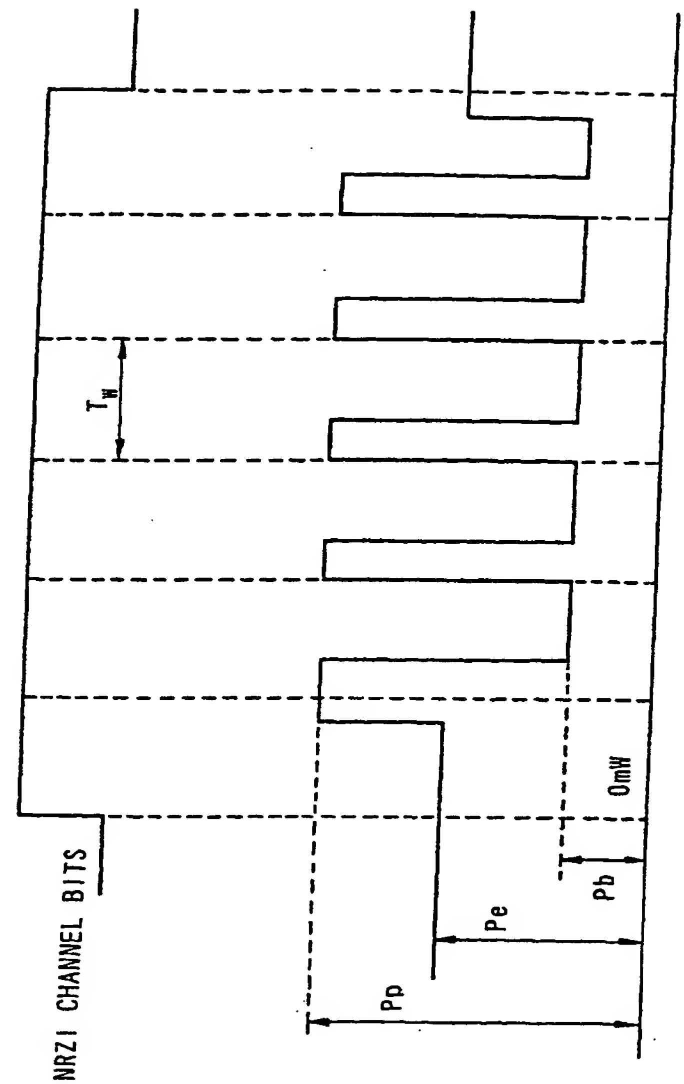
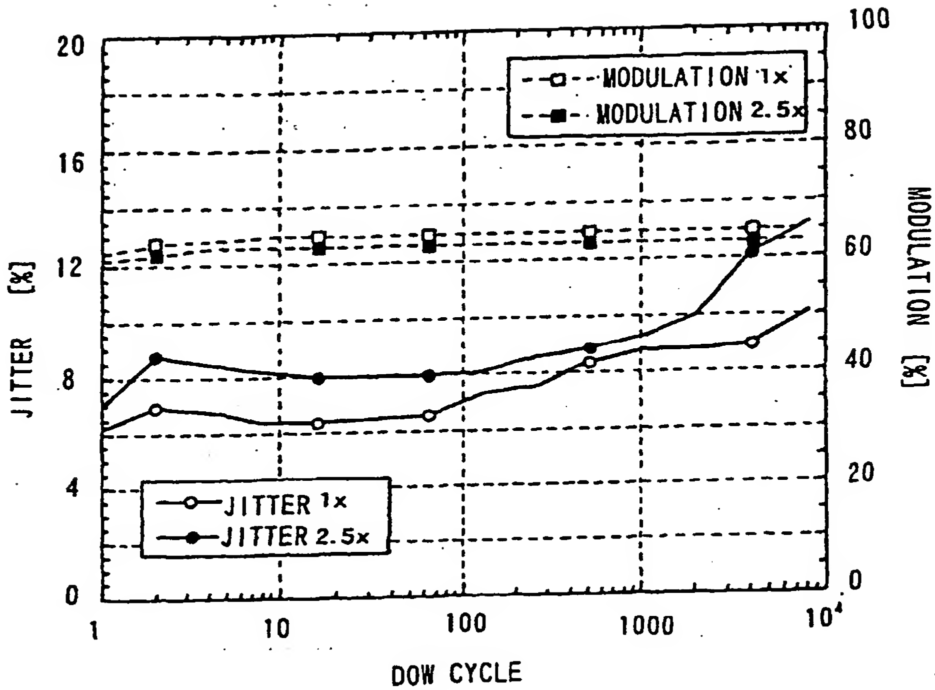


Fig. 7



20
16
12
8
4
0
JITTER [%]
100
80
60
40
20
0
MODULATION [%]
MODULATION 1x
MODULATION 2.5x
JITTER 1x
JITTER 2.5x
1
10
100
1000
10^4
DOW CYCLE